Differences in the pre-hospital management of women and men with stroke by emergency medical services in New South Wales

Xia Wang[1], Cheryl Carcel[1] iD , Benjumin Hsu[2], Sultana Shajahan[1], Matthew Miller[2], Sanne Peters[3], Deborah A Randall[2], Alys Havard[2], Julie Redfern[1,4], Craig S Anderson[1,5], Louisa Jorm[2], Mark Woodward[1]

The known: Stroke-related disability is greater for women than men, and their subsequent quality of life poorer. Investigations of sex differences in pre-hospital emergency medical service care for people with stroke have yielded inconsistent results.

The new: Women subsequently admitted to hospital with stroke were more likely than men to arrive by ambulance, but less likely to receive stroke-specific management during their journey. Among people under 70, women with stroke were more likely than men to be diagnosed by paramedics with conditions other than stroke.

The implications: Refining the assessment of symptoms in women in pre-hospital emergency services care could improve patient outcomes.

Abstract

Objectives: To examine whether pre-hospital emergency medical service care differs for women and men subsequently admitted to hospital with stroke.

Design, setting, participants: Population-based cohort study; analysis of linked Admitted Patient Data Collection and NSW Ambulance data for people admitted to New South Wales hospitals with a principal diagnosis of stroke at separation, 1 July 2005 – 31 December 2018.

Main outcome measures: Emergency medical service assessments, protocols, and management for patients subsequently diagnosed with stroke, by sex.

Results: Of 202 231 people hospitalised with stroke (mean age, 73 [SD, 14] years; 98 599 women [51.0%]), 101 357 were conveyed to hospital by ambulance (50.1%). A larger proportion of women than men travelled by ambulance (52.4% v 47.9%; odds ratio [OR], 1.09; 95% CI, 1.07–1.11), but time between the emergency call and emergency department admission was similar for both sexes. The likelihood of being assessed as having a stroke (adjusted OR [aOR], 0.97; 95% CI, 0.93–1.01) or subarachnoid haemorrhage (aOR, 1.22; 95% CI, 0.73–2.03) was similar for women and men, but women under 70 years of age were less likely than men to be assessed as having a stroke (aOR, 0.89; 95% CI, 0.82–0.97). Women were more likely than men to be assessed by paramedics as having migraine, other headache, anxiety, unconsciousness, hypertension, or nausea. Women were less likely than men to be managed according to the NSW Ambulance pre-hospital stroke care protocol (aOR, 0.95; 95% CI, 0.92–0.97), but the likelihood of basic pre-hospital care was similar for both sexes (aOR, 1.01; 95% CI, 0.99–1.04).

Conclusion: Our large population-based study identified sex differences in pre-hospital management by emergency medical services of women and men admitted to hospital with stroke. Paramedics should receive training that improves the recognition of stroke symptoms in women.

Landmark trials of intravenous thrombolysis[1] and endovascular thrombectomy[2] have transformed acute stroke care in recent years. As the efficacy of these treatments is highly time-dependent, rapid pre-hospital assessment is critical for optimising outcomes, and emergency medical services play a major role in realising their potential benefits.

Differences in pre-hospital activation of emergency medical services for men and women with stroke have been examined in several studies (Supporting Information, table 1). Some investigators found no sex differences,[3] others that women were more likely to be transported to hospital by ambulance,[4] or that the mean time between symptom onset and presenting to hospital was longer for women than men.[5] However, most studies were not population-based and sample sizes were small. As many investigations were not designed to detect sex differences in pre-hospital activation of emergency medical services, they did not consider important confounding factors, such as age.[3-5]

It is recognised that atypical clinical manifestations of stroke on initial presentation are more frequent in women.[6] Further, a large United States study found that the proportion of missed stroke diagnoses was nearly seven times as large for patients aged 18–44 years presenting to emergency departments (4.0%) as for those aged 75 years or more (0.6%).[7]

In our population-based study, we examined the pre-hospital care and management provided by emergency medical services to people admitted to hospital in New South Wales with stroke diagnoses. We investigated whether pre-hospital emergency medical services care was different for women and men, and whether any sex differences were influenced by age.

Methods

We analysed linked administrative data for women and men admitted to NSW hospitals during 1 July 2005 – 31 December 2018 with a principal diagnosis and one additional diagnosis code for stroke at separation (International Classification of Diseases, tenth revision, Australian modification [ICD-10-AM] codes I60–68, G45) and no previous admissions with a stroke diagnosis in any diagnosis field after 31 July 2001 (ie, lookback period of four years).

The NSW Admitted Patient Data Collection (APDC) includes hospital records from all NSW public and private hospitals and day procedure centres. APDC records include demographic data

(age, sex, marital status, country of birth, Indigenous status, hospital region) and clinical code information (diagnoses during the episode of care).

NSW Ambulance data collections contain operational information from the computer-aided dispatch system and information documented by paramedics in the patient health care record (PHCR) or electronic medical record (eMR). The PHCR database comprises electronic transcripts of paramedics' paper case sheets, while eMR data are directly derived from

electronic case sheets entered into the eMR system from devices in the ambulance. The eMR has been the preferred format since its staged introduction in 2010, but the PHCR is still used for some care episodes.

Study factors

The NSW Ambulance eMR (but not the PHCR) captures the documented assessments of patients by paramedics. The assessments we considered in our study were cerebrovascular

---

1 Baseline characteristics by sex and arrivals by ambulance for patients admitted to New South Wales hospitals with a principal diagnosis of stroke, 2005–2018

Characteristics	Did not arrive by ambulance			Arrived by ambulance			OR (95% CI)*
	Total	Women	Men	Total	Women	Men	
All patients	100 874	46 907	53 967	101 357	51 692	49 665	1.09 (1.07–1.11)
Age (years), mean (SD)	70.4 (14.3)	71.6 (15.0)	69.3 (13.6)	75 (14)	78 (13.9)	73 (13.6)	
0–39	3392 (3.4%)	1775 (3.8%)	1617 (3.0%)	2041 (2.0%)	1004 (1.9%)	1037 (2.1%)	0.88 (0.79–0.98)
40–69	39 467 (39.1%)	16 286 (34.7%)	23 181 (43.0%)	27 169 (26.8%)	10 945 (21.2%)	16 224 (32.7%)	0.96 (0.93–0.99)
70 or more	58 015 (57.5%)	28 846 (61.5%)	29 169 (54.1%)	72 146 (71.2%)	39 743 (76.9%)	32 403 (65.2%)	1.24 (1.21–1.27)
Country of birth							
Australia	70 350 (69.8%)	33 409 (71.3%)	36 941 (68.5%)	69 678 (68.9%)	36 390 (70.5%)	33 288 (67.2%)	1.18 (1.14–1.22)
Elsewhere	30 383 (30.2%)	13 436 (13.3%)	16 947 (31.5%)	31 487 (31.1%)	15 205 (29.5%)	16 282 (32.8%)	1.21 (1.18–1.23)
Marital status							
With partner	57 977 (57.5%)	20 893 (44.5%)	37 084 (68.7%)	50 277 (49.6%)	18 492 (35.8%)	31 785 (64.0%)	1.03 (1.01–1.06)
Without partner	40 334 (40.0%)	24 747 (52.8%)	15 587 (28.9%)	49 088 (48.4%)	32 184 (62.3%)	16 904 (34.0%)	1.20 (1.17–1.23)
Unknown	2563 (2.5%)	1267 (2.7%)	1296 (2.4%)	1992 (2.0%)	1016 (2.0%)	976 (2.0%)	1.07 (0.95–1.20)
Indigenous status							
Aboriginal or Torres Strait Islander	1549 (1.5%)	835 (1.8%)	714 (1.3%)	1547 (1.5%)	774 (1.5%)	773 (1.6%)	0.86 (0.74–0.99)
Non-Indigenous	98 493 (97.7%)	45 706 (97.5%)	52 787 (97.9%)	98 930 (97.6%)	50 464 (97.7%)	48 466 (97.6%)	1.20 (1.18–1.22)
Did not respond	788 (0.8%)	343 (0.7%)	445 (0.8%)	853 (0.8%)	433 (0.8%)	420 (0.9%)	1.34 (1.10–1.63)
Region							
Urban	68 472 (69.6%)	32 138 (70.2%)	36 334 (69.2%)	70 550 (71.1%)	36 366 (71.7%)	34 184 (70.6%)	1.20 (1.18–1.23)
Regional	29341 (29.8%)	215 (0.5%)	288 (0.6%)	28310 (28.6%)	14234 (28.1%)	14076 (29.1%)	1.20 (1.16–1.24)
Remote	503 (0.5%)	13 436 (29.3%)	15 905 (30.3%)	305 (0.3%)	143 (0.3%)	162 (0.3%)	1.19 (0.89–1.57)
Stroke subtype							
Ischaemic stroke	23 885 (23.7%)	10 395 (22.2%)	13 490 (25.0%)	38 782 (38.3%)	18 775 (36.3%)	20 007 (40.3%)	1.22 (1.18–1.26)
Intracerebral haemorrhage	4653 (4.6%)	2078 (4.4%)	2575 (4.8%)	10 981 (10.8%)	5528 (10.7%)	5453 (11.0%)	1.26 (1.17–1.35)
Subarachnoid haemorrhage	2141 (2.1%)	1226 (2.6%)	915 (1.7%)	4343 (4.3%)	2718 (5.3%)	1625 (3.3%)	1.25 (1.12–1.39)
Transient ischaemic stroke	42 232 (41.9%)	21 018 (44.8%)	21 214 (39.3%)	28 126 (27.8%)	14 718 (28.5%)	13 408 (27.0%)	1.11 (1.08–1.14)
Occlusion and stenosis of prevertebral arteries	16 403 (16.3%)	6661 (14.2%)	9742 (18.1%)	2503 (4.8%)	2578 (5.2%)	5081 (5.0%)	1.42 (1.33–1.51)
Not determined	11 560 (11.5%)	5529 (11.8%)	6031 (11.2%)	14 044 (13.9%)	7450 (14.4%)	6594 (13.3%)	1.23 (1.17–1.30)

CI = confidence interval; OR = odds ratio; SD = standard deviation. * Proportion transported to hospital by ambulance: women v men. ◆

2 Emergency medical service clinical measures for patients subsequently admitted to NSW hospitals with principal diagnosis of stroke, 2005–2018*

	Univariable analysis			Multivariable analysis[†]		
Clinical measure*	Women	Men	Mean difference (95% CI)	Women	Men	Adjusted mean difference (95% CI)
All patients	51 692	49 665				
Systolic blood pressure (mmHg), mean (95% CI)	152.7 (152.4–152.9)	149.6 (149.3–149.9)	3.05 (2.66–3.45)	149.0 (147.4–150.6)	146.8 (145.2–148.4)	2.23 (1.83–2.63)
Number of patients	*47 125*	*45 698*				
Diastolic blood pressure (mmHg), mean (95% CI)	82.6 (82.3–82.8)	83.1 (82.9–83.3)	–0.55 (–0.86 to –0.24)	82.1 (80.8–83.3)	82.0 (80.8–83.3)	0.05 (–0.27 to 0.37)
Number of patients	*37 281*	*36 420*				
Glasgow Coma Scale, mean score (95% CI)	13.5 (13.5–13.5)	13.9 (13.9–13.9)	–0.39 (–0.42 to –0.35)	12.9 (12.7–13.0)	13.2 (13.0–13.3)	–0.30 (–0.33 to –0.27)
Glasgow Coma Scale, median score (IQR)	15 (14–15)	15 (14–15)	—	—	—	—
Number of patients	*47 105*	*45 402*				

CI = confidence interval; IQR = interquartile range. * For patients with ambulance electronic medical records or paper-based patient health care records. † Adjusted for age (continuous), marital status, country of birth, Indigenous status, hospital region, year of stroke onset, and stroke subtype. ◆

and cardiovascular conditions, as well as stroke mimics: acute coronary syndrome, acute myocardial infarction, acute pulmonary oedema, anxiety, arrhythmia, cardiac arrest, collapse, dizziness, emotional distress, faint, headache, hyperglycaemia, hypoglycaemia, hypertension, hypotension, hyperventilation, migraine, mobility problem, nausea, pain, psychiatric episode, seizure, stroke, subarachnoid haemorrhage, transient ischaemic attack, unconsciousness, vertigo, visual disturbance, vomiting, or weakness, as well as "no problem identified" or "unknown problem". NSW Ambulance PHCR and eMR records include information on vital status (blood pressure, Glasgow Coma Scale score), management protocols applied,[8,9] and treatment administered by paramedics. Protocols explored in this study were basic pre-hospital care, cardiac arrest care, and stroke care; treatments included were oxygen therapy and ventilation.

According to the NSW Ambulance stroke care protocol, all patients with FAST warning signs (facial drooping, arm weakness, speech difficulties) should be transported to the highest level stroke care facility available within 90 minutes. During transport, paramedics regularly repeat and document physical examinations and physiological observations to identify trends, clinical deterioration, and response to treatment. Associated conditions (eg, hypo- or hyperglycaemia, altered level of consciousness) are treated as required. For people who meet hyperacute stroke treatment (eg, thrombolysis) criteria, paramedics complete a stroke process sheet, proceed to the hospital without delay, and notify the receiving hospital via the control centre. The minor variations to the protocol during 2005–2018 are summarised in Supporting Information, table 2.

Statistical analysis

We summarise patients' demographic characteristics at hospitalisation as descriptive statistics, by sex. We summarise the assessments, applied protocols, and treatments during ambulance transport as descriptive statistics, by sex. We compared values for men and women as adjusted mean differences, or as adjusted odds ratios (aORs) with 95% confidence intervals (CIs) estimated in logistic regression models adjusted for age, marital status, country of birth, Indigenous status, hospital region, year of stroke onset, and stroke subtype. We also undertook *a priori* subgroup analyses by age group (under 70 years, 70 years or older), including an age*sex interaction term. Statistical analyses were conducted in SAS 9.4.

Ethics approval

This study was approved by the research ethics committees of NSW Population and Health Services (HREC/18/CIPHS/56), the Aboriginal Health and Medical Research Council of NSW (1503/19), and the Australian Institute of Health and Welfare (EO2018/2/431).
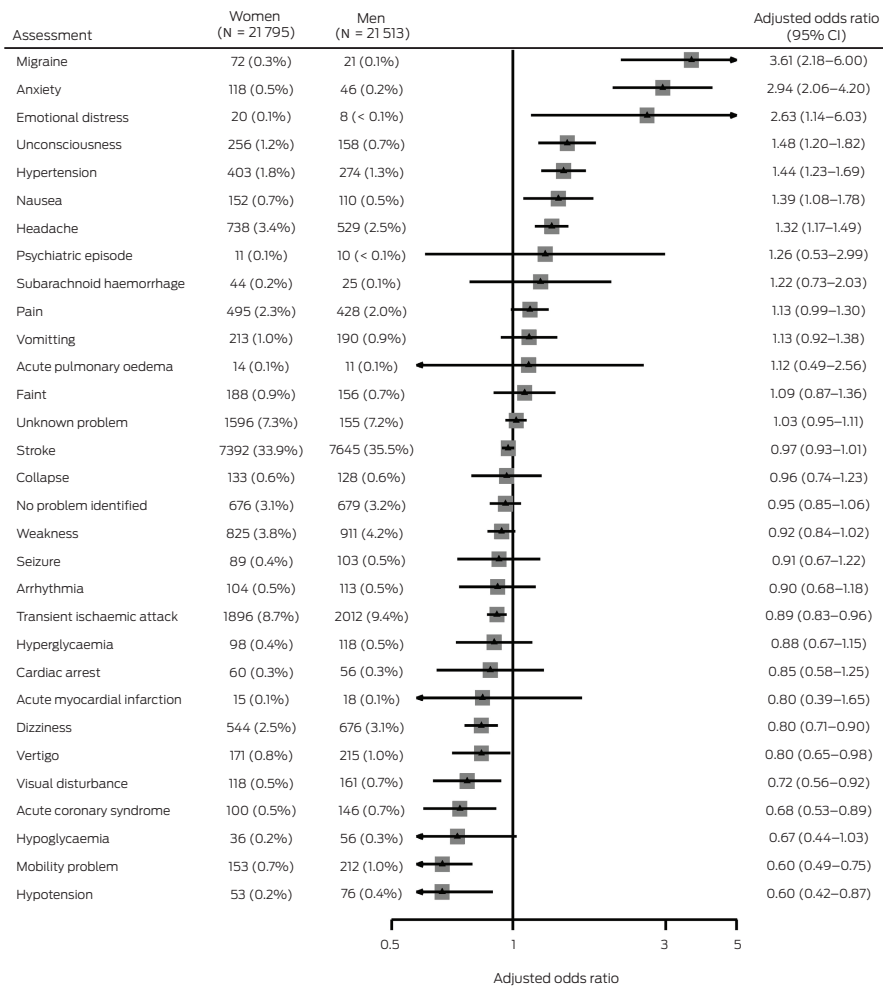
Results

Of 202 231 people hospitalised with a stroke diagnosis (mean age, 73 years; standard deviation [SD], 14 years; 98 599 women [51.0%]; 140 028 born in Australia [69.4%]), 101 357 were conveyed to hospital by ambulance (50.1%). The mean age of the women (75 years; SD, 14.7 years) was marginally higher than for men (71 years; SD, 13.7 years); other demographic and clinical differences were also small (Supporting Information, table 3).

Characteristics of patients who arrived by ambulance

A larger proportion of women than of men arrived at hospital by ambulance (52.4% v 47.9%; OR, 1.09; 95% CI, 1.07–1.11). A smaller proportion of women than of men who arrived by ambulance were aged 40–69 years (21.2% v 32.7%; aOR, 0.70; 95% CI, 0.64–0.76), but the proportion of women who arrived by ambulance aged 70 or more years was larger (76.9% v 65.2%; aOR, 1.29; 95% CI, 1.16–1.38) (Box 1). Mean systolic blood pressure (ambulance measures) was similar for women and men (adjusted: 149.0 mmHg; 95% CI, 147.4–150.6 mmHg v 146.8 mmHg; 95% CI, 145.2–148.4 mmHg), as were mean Glasgow Coma Scale scores (adjusted: 12.9; 95% CI, 12.7–13.0 v 13.2; 95% CI, 13.0–13.3) (Box 2).

3 Final emergency medical service (ambulance) assessments of people subsequently admitted to NSW hospitals with principal diagnosis of stroke, 2005–2018: adjusted multivariable analyses (patients with ambulance electronic medical records only)*

Assessment	Women (N = 21 795)	Men (N = 21 513)	Adjusted odds ratio (95% CI)
Migraine	72 (0.3%)	21 (0.1%)	3.61 (2.18–6.00)
Anxiety	118 (0.5%)	46 (0.2%)	2.94 (2.06–4.20)
Emotional distress	20 (0.1%)	8 (< 0.1%)	2.63 (1.14–6.03)
Unconsciousness	256 (1.2%)	158 (0.7%)	1.48 (1.20–1.82)
Hypertension	403 (1.8%)	274 (1.3%)	1.44 (1.23–1.69)
Nausea	152 (0.7%)	110 (0.5%)	1.39 (1.08–1.78)
Headache	738 (3.4%)	529 (2.5%)	1.32 (1.17–1.49)
Psychiatric episode	11 (0.1%)	10 (< 0.1%)	1.26 (0.53–2.99)
Subarachnoid haemorrhage	44 (0.2%)	25 (0.1%)	1.22 (0.73–2.03)
Pain	495 (2.3%)	428 (2.0%)	1.13 (0.99–1.30)
Vomitting	213 (1.0%)	190 (0.9%)	1.13 (0.92–1.38)
Acute pulmonary oedema	14 (0.1%)	11 (0.1%)	1.12 (0.49–2.56)
Faint	188 (0.9%)	156 (0.7%)	1.09 (0.87–1.36)
Unknown problem	1596 (7.3%)	155 (7.2%)	1.03 (0.95–1.11)
Stroke	7392 (33.9%)	7645 (35.5%)	0.97 (0.93–1.01)
Collapse	133 (0.6%)	128 (0.6%)	0.96 (0.74–1.23)
No problem identified	676 (3.1%)	679 (3.2%)	0.95 (0.85–1.06)
Weakness	825 (3.8%)	911 (4.2%)	0.92 (0.84–1.02)
Seizure	89 (0.4%)	103 (0.5%)	0.91 (0.67–1.22)
Arrhythmia	104 (0.5%)	113 (0.5%)	0.90 (0.68–1.18)
Transient ischaemic attack	1896 (8.7%)	2012 (9.4%)	0.89 (0.83–0.96)
Hyperglycaemia	98 (0.4%)	118 (0.5%)	0.88 (0.67–1.15)
Cardiac arrest	60 (0.3%)	56 (0.3%)	0.85 (0.58–1.25)
Acute myocardial infarction	15 (0.1%)	18 (0.1%)	0.80 (0.39–1.65)
Dizziness	544 (2.5%)	676 (3.1%)	0.80 (0.71–0.90)
Vertigo	171 (0.8%)	215 (1.0%)	0.80 (0.65–0.98)
Visual disturbance	118 (0.5%)	161 (0.7%)	0.72 (0.56–0.92)
Acute coronary syndrome	100 (0.5%)	146 (0.7%)	0.68 (0.53–0.89)
Hypoglycaemia	36 (0.2%)	56 (0.3%)	0.67 (0.44–1.03)
Mobility problem	153 (0.7%)	212 (1.0%)	0.60 (0.49–0.75)
Hypotension	53 (0.2%)	76 (0.4%)	0.60 (0.42–0.87)

Adjusted odds ratio (x-axis: 0.5, 1, 3, 5)

CI = confidence interval. * Adjusted for age (continuous), marital status, country of birth, Indigenous status, hospital region, year of stroke onset, and stroke subtype. Univariable analyses are included in the Supporting Information, table 6. ◆

disturbance (aOR, 0.72; 95% CI, 0.58–0.92), acute coronary syndrome (aOR, 0.68; 95% CI, 0.53–0.89), a mobility problem (aOR, 0.60; 95% CI, 0.49–0.75), or hypotension (aOR, 0.60; 95% CI, 0.42–0.87) (Box 3).

Among patients under 70 years of age, women were less likely than men to be assessed as having a stroke (aOR, 0.89, 95% CI, 0.82–0.97); among those aged 70 years or more, women were more likely than men to be assessed as having hypertension (aOR, 1.86; 95% CI, 1.52–2.29) and less likely to be assessed as having dizziness (aOR, 0.74; 95% CI, 0.64–0.85). The likelihood of no problem being identified was not significantly different for women and men in either age group (Box 4).

Protocols applied and treatment administered by ambulance paramedics

Women were less likely than men to be managed according to the pre-hospital stroke care protocol (aOR, 0.95; 95% CI, 0.92–0.97), but basic pre-hospital care was similar for both sexes (aOR, 1.01; 95% CI, 0.99–1.04), as was the use of oxygen and ventilation (Box 5).

Discussion

Our large population-based study, an analysis of data for people admitted to NSW hospitals with stroke during 2005–2018, examined sex differences in their management by emergency medical (ambulance) services. We found that women were more likely than men to arrive at hospital by ambulance, but less likely to receive stroke care management prior to hospital admission. Among patients under 70 years of age, women were less likely than men to be assessed by paramedics as having a stroke, but there was no significant difference for older patients.

About half of all patients admitted to hospital with stroke were transported by ambulance, and the proportion was larger for women (52.4% v 47.9%). Previous studies (Supporting Information, table 1) have found that the proportion of cases in which emergency medical services were activated for people with stroke ranged from 17% in Brazil[10] to 82% in the United Kingdom.[3] Sex differences in emergency medical service care have been reported for people with many illnesses and injuries,[11,12] including stroke,[3-5] but the conclusions drawn have been inconsistent, indicating the need for large population-based studies to identify the reasons for these differences.

Among patients under 70 years of age, women later diagnosed with stroke were less likely than men to be assessed by paramedics as having stroke. Stroke is more frequently missed in women than in men; atypical clinical manifestations are more frequent in women, and implicit bias in evaluations by health care providers is also possible.[6,13] We found that women subsequently diagnosed with

For patients with ambulance eMRs, time between the emergency call and emergency department admission was also similar for both sexes (Supporting Information, table 4).
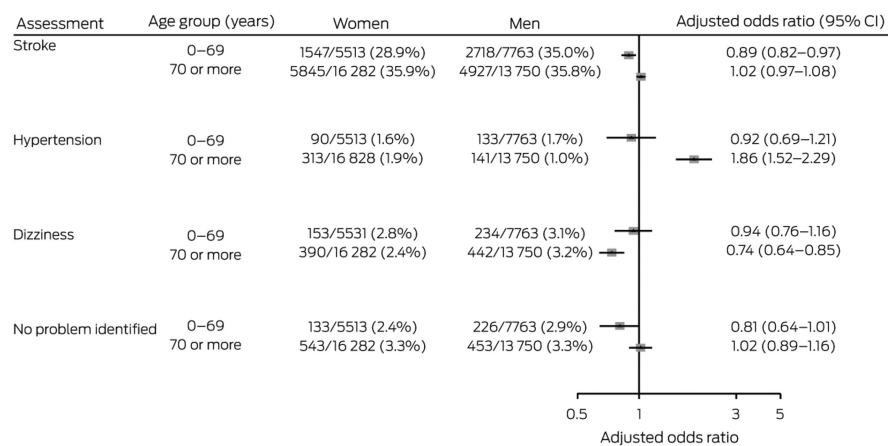
Assessments of patients by ambulance paramedics

Socio-demographic characteristics (including age and sex) and stroke subtype were similar for patients with eMR or PHCR records (Supporting Information, table 5). Paramedic assessment data were available for the 43 308 patients with ambulance eMRs (42.7% of those transported by ambulance). The likelihood of being assessed as having a stroke (aOR, 0.97; 95% CI, 0.93–1.01) or subarachnoid haemorrhage (aOR, 1.22; 95% CI, 0.73–2.03) was similar for women and men. Women were more likely than men to be assessed as having migraine (aOR, 3.61; 95% CI, 2.18–6.00), anxiety (aOR, 2.94; 95% CI, 2.06–4.20), unconsciousness (aOR, 1.48; 95% CI, 1.20–1.82), hypertension (aOR, 1.44; 95% CI, 1.23–1.69), nausea (aOR, 1.39; 95% CI, 1.08–1.78), or headache (aOR, 1.32; 95% CI, 1.17–1.49). Women were less likely than men to be assessed as having a transient ischaemic attack (aOR, 0.89; 95% CI, 0.83–0.96), dizziness (aOR, 0.80; 95% CI, 0.71–0.90), visual

4 Final emergency medical service (ambulance) assessments of people subsequently admitted to NSW hospitals with principal diagnosis of stroke, 2005–2018: adjusted multivariable analyses (patients with ambulance electronic medical records only), by age group*

Assessment	Age group (years)	Women	Men	Adjusted odds ratio (95% CI)
Stroke	0–69	1547/5513 (28.9%)	2718/7763 (35.0%)	0.89 (0.82–0.97)
	70 or more	5845/16 282 (35.9%)	4927/13 750 (35.8%)	1.02 (0.97–1.08)
Hypertension	0–69	90/5513 (1.6%)	133/7763 (1.7%)	0.92 (0.69–1.21)
	70 or more	313/16 828 (1.9%)	141/13 750 (1.0%)	1.86 (1.52–2.29)
Dizziness	0–69	153/5531 (2.8%)	234/7763 (3.1%)	0.94 (0.76–1.16)
	70 or more	390/16 282 (2.4%)	442/13 750 (3.2%)	0.74 (0.64–0.85)
No problem identified	0–69	133/5513 (2.4%)	226/7763 (2.9%)	0.81 (0.64–1.01)
	70 or more	543/16 282 (3.3%)	453/13 750 (3.3%)	1.02 (0.89–1.16)

CI = confidence interval. * Adjusted for age (continuous), marital status, country of birth, Indigenous status, hospital region, year of stroke onset, and stroke subtype. ◆

stroke were more frequently assessed by paramedics as having stroke mimics (eg, headache or migraine, anxiety, unconsciousness) than men, contributing to delayed recognition and treatment of stroke, consistent with the findings of other studies.[14-17]

We found that the stroke care protocol was less likely to be invoked during ambulance transport for women than for men. Although the absolute difference was small (women, 49.5%; men, 51.4%), in-hospital treatment may be delayed for a considerable number of women. Further, delayed initiation of effective treatment, such as reperfusion therapy,[18] could have greater consequences for women because stroke outcomes are generally poorer for women than men,[19] although women derive at least equivalent benefit from

5 Management protocols and treatments administered by emergency medical service for people subsequently admitted to NSW hospitals with principal diagnosis of stroke, 2005–2018: adjusted multivariable analyses (all patients)*

Outcome	Women (N = 51 692)	Men (N = 49 665)	Adjusted odds ratio (95% CI)
Management protocol			
Basic patient care	33 941 (65.7%)	32 423 (65.3%)	1.01 (0.99–1.04)
Stroke care	25 580 (49.5%)	25 501 (51.4%)	0.95 (0.92–0.97)
Cardiac arrest	176 (0.3%)	136 (0.3%)	1.06 (0.84–1.33)
Treatment			
Oxygen therapy	17 451 (33.8%)	17 0.32 (34.3%)	0.99 (0.96–1.01)
Ventilation	46 (0.1%)	33 (0.1%)	1.13 (0.71–1.81)

CI = confidence interval. * Adjusted for age (continuous), marital status, country of birth, Indigenous status, hospital region, year of stroke onset, and stroke subtype. Univariable analyses are included in the Supporting Information, table 7. ◆

appropriate treatment.[20] Awareness of these differences could have both clinical and financial consequences, given the costs of death and disability, including those of long term care.[21] Similar sex-related differences have been reported for myocardial infarction,[22] and emergency department doctors are less likely to identify coronary artery disease as a cause of chest pain in women or to recommend diagnostic tests.[23] Women are also less likely to report that their health care providers told them they were at risk for heart disease prior to an index myocardial infarction event, despite risk factor burdens similar to those of men.[24]
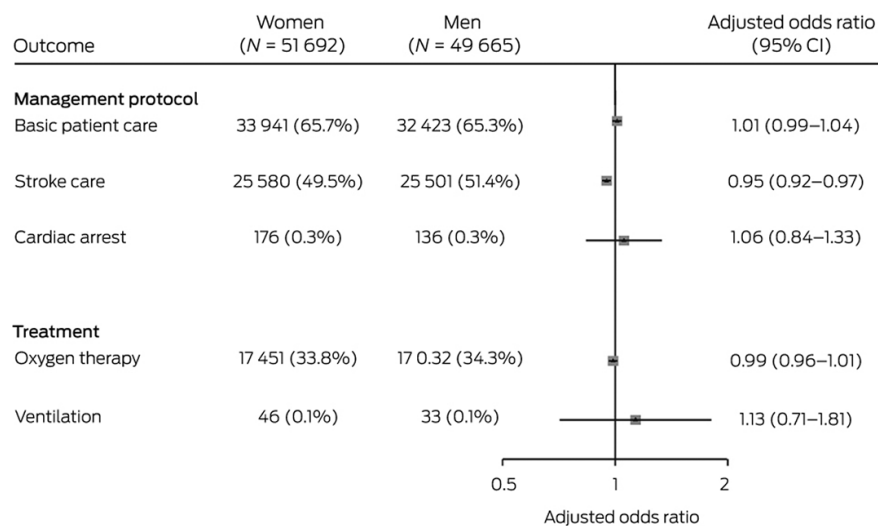
Limitations

The strength of our study was its whole-of-population analysis, permitting the generation of a comprehensive profile of pre-hospital emergency medical service care for patients subsequently admitted with stroke. However, a range of stroke mimics were diagnosed by ambulance paramedics. While recognising the possible inaccuracy of specific ambulance reporting diagnoses, our intent was to present a descriptive profile and to assess differences in presentation times for people with stroke mimics. We could not link pre-hospital care data with differences in mortality or morbidity data by sex. We could not assess symptoms presented by patients, reasons for the management chosen by paramedics, or management prior to the arrival of paramedics. Further, we had no data on potential confounders in the relationship between sex and emergency medical service management, such as risk factors for cardiovascular disease (eg, smoking, physical activity, body mass index, alcohol consumption), neurological severity at the time of the stroke, pre-morbid dependence, and cardiovascular and cerebrovascular disease history. As information for 57% of people was documented only by PHCR, paramedic assessment, care protocol, and treatment information were missing for these patients, possibly causing selection bias.

Conclusion

Pre-hospital emergency medical service care in NSW differs for women and men subsequently admitted to hospital with stroke. In particular, women are less likely to be managed with stroke-specific protocols during ambulance transport to hospital. Paramedics should re-consider their assessment of women during pre-hospital emergency medical service care. Improving paramedic training in symptom recognition, particularly

in women, may reduce time to treatment and improve outcomes for people with stroke.

1 Emberson J, Lees KR, Lyden P, et al; Stroke Thrombolysis Trialists' Collaborative Group. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischemic stroke: a meta-analysis of individual patient data from randomized trials. *Lancet* 2014; 384: 1929-1935.

2 Saver JL, Goyal M, van der Lugt A, et al; HERMES Collaborators. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: a meta-analysis. *JAMA* 2016; 316: 1279-1288.

3 Price CI, Rae V, Duckett J, et al. An observational study of patient characteristics associated with the mode of admission to acute stroke services in North East, England. *PLoS One* 2013; 8: e76997.

4 Reeves MJ, Fonarow GC, Zhao X, et al; Get With The Guidelines-Stroke Steering Committee and Investigators. Quality of care in women with ischemic stroke in the GWTG program. *Stroke* 2009; 40: 1127-1133.

5 Park SJ, Shin SD, Ro YS, et al. Gender differences in emergency stroke care and hospital outcome in acute ischemic stroke: a multicenter observational study. *Am J Emerg Med* 2013; 31: 178-184.

6 Yu AYX, Penn AM, Lesperance ML, et al; SpecTRA Study Group. Sex differences in presentation and outcome after an acute transient or minor neurologic event. *JAMA Neurol* 2019; 76: 962-968.

7 Newman-Toker DE, Moy E, Valente E, et al. Missed diagnosis of stroke in the emergency department: a cross-sectional analysis of a large population-based sample. *Diagnosis* 2014; 1: 155-166.

8 New South Wales Ambulance. NSW Ambulance protocols 2016, version 2.0.5. Updated 2 Sept 2021. https://apps.apple.com/au/app/nsw-ambulance-protocols/id1103576564 (viewed Oct 2021).

9 Ambulance Service of New South Wales. Protocols and pharmacology: 2014 amendment. Updated Jan 2014. http://www.australianparamedicalcollege.com.au/learning-material/general-information/ASNSW-protocols-pharmacology-2014.pdf (viewed Oct 2021).

10 Kuster GW, Bueno Alves M, Cendoroglo Neto M, Silva GS. Determinants of emergency medical services use in a Brazilian population with acute ischemic stroke. *J Stroke Cerebrovasc Dis* 2013; 22: 244-249.

11 Weiss SJ, Ernst AA, Phillips J, Hill B. Gender differences in state-wide EMS transports. *Am J Emerg Med* 2000; 18: 666-670.

12 Canto JG, Zalenski RJ, Ornato JP, et al; National Registry of Myocardial Infarction 2 Investigators. Use of emergency medical services in acute myocardial infarction and subsequent quality of care: observations from the National Registry of Myocardial Infarction 2. *Circulation* 2002; 106: 3018-3023.

13 Tarnutzer AA, Lee SH, Robinson KA, et al. ED misdiagnosis of cerebrovascular events in the era of modern neuroimaging: a meta-analysis. *Neurology* 2017; 88: 1468-1477.

14 Gall SL, Donnan G, Dewey HM, et al Sex differences in presentation, severity, and management of stroke in a population-based study. *Neurology.* 2010; 74: 975-981.

15 Kropp P, Holzhausen M, Kolodny E, et al; Stroke in Young Fabry Patients (sifap) Investigators. Headache as a symptom at stroke onset in 4431 young ischaemic stroke patients. Results from the "Stroke in Young Fabry Patients (SIFAP1) study". *J Neural Transm* 2013; 120: 1433-1440.

16 Venkat A, Cappelen-Smith C, Askar S, et al. Factors associated with stroke misdiagnosis in the emergency department: a retrospective case-control study. *Neuroepidemiology* 2018; 51: 123-127.

17 Zrelak PA. Sex-based differences in symptom perception and care-seeking behavior in acute stroke. *Perm J* 2018; 22: 18-042.

18 Mainz J, Andersen G, Valentin JB, et al. Disentangling sex differences in use of reperfusion therapy in patients with acute ischemic stroke. *Stroke* 2020; 51: 2332-2338.

19 Carcel C, Wang X, Sandset EC, et al. Sex differences in treatment and outcome after stroke: pooled analysis including 19 000 participants. *Neurology* 2019; 93: e2170-e2180.

20 Bushnell C, Howard VJ, Lisabeth L, et al. Sex differences in the evaluation and treatment of acute ischaemic stroke. *Lancet Neurol* 2018; 17: 641-650.

21 Synhaeve NE, Arntz RM, Maaijwee NAM, et al. Poor long-term functional outcome after stroke among adults aged 18 to 50 years: follow-up of transient ischemic attack and stroke patients and unelucidated risk factor evaluation (FUTURE) study. *Stroke* 2014; 45: 1157-1160.

22 Hsu B, Carcel C, Wang X, et al. Sex differences in emergency medical services management of patients with myocardial infarction: analysis of routinely collected data for over 110 000 patients. *Am Heart J* 2021; 241: 87-91.

23 Golden KE, Chang AM, Hollander JE. Sex preferences in cardiovascular testing: the contribution of the patient–physician discussion. *Acad Emerg Med* 2013; 20: 680-688.

24 Leifheit-Limson EC, D'Onofrio G, Daneshvar M, et al. Sex differences in cardiac risk factors, perceived risk, and health care provider discussion of risk and risk modification among young patients with acute myocardial infarction: the VIRGO Study. *J Am Coll Cardiol* 2015; 66: 1949-1957. ■

Supporting Information

Additional Supporting Information is included with the online version of this article.